CLAIMS:

1. A method for producing controllable light emission from a semiconductor device, comprising the steps of:

providing a heterojunction bipolar transistor device that includes collector, base, and emitter regions; and

applying electrical signals across terminals coupled with said collector, base, and emitter regions to cause light emission by radiative recombination in the base region.

2. The method as defined by claim 1, wherein said step of applying electrical signals includes applying a collector-to-emitter voltage and modulating light output by applying a modulating base current.

3. The method as defined by claim 2, wherein said modulating base current is applied at a frequency of at least 1 MHz.

4. The method as defined by claim 3, wherein said step of applying signals includes applying an emitter-to-base forward bias and base-to-collector reverse bias.

5. The method as defined by claim 1, wherein said step of providing a heterojunction bipolar transistor device comprises providing a device formed of direct bandgap materials.

6. The method as defined by claim 2, wherein said step of providing a heterojunction bipolar transistor device comprises providing a device formed of direct bandgap materials.

7. The method as defined by claim 1, wherein said step of applying electrical signals to cause light emission includes applying base current to produce light emission that is substantially proportional to the applied base current.

8. The method as defined by claim 2, wherein said step of applying electrical signals to cause light emission includes applying base current to produce light emission that is substantially proportional to the applied base current.

9. The method as defined by claim 5, wherein said step of applying electrical signals to cause light emission includes applying base current to produce light emission that is substantially proportional to the applied base current.

10. The method as defined by claim 1, wherein said step of providing a heterojunction bipolar transistor device comprises providing said device with a heavily doped base region.

11. The method as defined by claim 6, wherein said step of providing a heterojunction bipolar transistor device comprises providing said device with a heavily doped base region.

12. The method as defined by claim 8, wherein said step of providing a heterojunction bipolar transistor device comprises providing said device with a heavily doped base region.

13. The method as defined by claim 1, wherein said step of providing a heterojunction bipolar transistor device comprises providing said device with a heavily doped p-type base region.

14. The method as defined by claim 1, further comprising providing a laser cavity on said device to obtain laser emission.

15. The method as defined by claim 5, further comprising providing a laser cavity on said device to obtain laser emission.

16. A device having an input port for receiving an electrical input signal, an electrical output port for outputting an electrical signal modulated by said input signal, and an optical output port for outputting an optical signal modulated by said input signal, said device comprising a heterojunction bipolar transistor device that includes collector, base, and emitter regions, said input port comprising an electrode coupled with said base region, said electrical output port comprising electrodes coupled with said collector and emitter regions, and said optical output port comprising an optical coupling with said base region.

17. The device as defined by claim 16, wherein said heterojunction bipolar transistor device comprises regions of direct bandgap semiconductor material.

18. The device as defined by claim 16, wherein said input port comprises electrodes coupled with the base and emitter regions of said device, and said output electrical port comprises electrodes coupled with the collector and emitter regions of said device.

19. The device as defined by claim 16, wherein said input port comprises electrodes coupled with the base and emitter regions of

said device, and said output electrical port comprises electrodes coupled with the collector and emitter regions of said device.

20. A semiconductor laser, comprising:

a heterojunction bipolar transistor structure comprising collector, base, and emitter of direct bandgap semiconductor materials;

an optical resonant cavity enclosing at least a portion of said transistor structure; and

means for coupling electrical signals with said collector, base, and emitter regions to cause laser emission from said device.

21. The laser as defined by claim 20, wherein at least a portion of said heterojunction transistor structure is in layered form, and wherein said optical resonant cavity is a lateral cavity with respect to the layer plane of said at least a portion of said structure.

22. The laser as defined by claim 20, wherein at least a portion of said heterojunction transistor structure is in layered form, and wherein said optical resonant cavity is a vertical cavity with respect to the layer plane of said at least a portion of said structure.

23. The laser as defined by claim 20, wherein said heterojunction bipolar transistor structure comprises an InP-based device.

24. The laser as defined by claim 20, wherein said heterojunction bipolar transistor structure comprises a GaAs-based device.

25. The laser as defined by claim 20, wherein said heterojunction bipolar transistor structure comprises a GaN-based device.

26. A semiconductor device for producing controllable light emission, comprising:

a heterojunction bipolar transistor structure comprising collector, base, and emitter of direct bandgap semiconductor materials;

at least one quantum well disposed in the base region; and

means for coupling electrical signals with said collector, base, and emitter regions to cause light emission from said device by radiative recombination in the base region.

27. The device as defined by claim 26, further comprising an optical resonant cavity enclosing at least a portion of said transistor structure.

28. The device as defined by claim 26, wherein said means for coupling electrical signals includes means for applying a collector-to-emitter voltage and for modulating light output with applied base current.

29. The device as defined by claim 27, wherein said means for coupling electrical signals includes means for applying a collector-to-emitter voltage and for modulating light output with applied base current.

30. A method for producing light modulated with an input electrical signal, comprising the steps of:

providing a heterostructure bipolar transistor device that includes collector, base, and emitter regions of direct bandgap semiconductor materials, said base region being heavily doped;

applying electrical signals to said collector, base, and emitter regions to cause light emission by radiative recombination in the base region; and

controlling the base current of said transistor device with said input electrical signal to modulate the light emission from said transistor device.

31. The method as defined by claim 30, wherein said input electrical signal includes frequencies of at least 1 MHz.

32. The method as defined by claim 30, wherein said step of applying signals includes applying an emitter-to-base forward bias and base-to-collector reverse bias.

33. The method as defined by claim 30, wherein said step of applying electrical signals to cause light emission includes applying base current to produce light emission that is substantially proportional to the applied base current.

34. A method for producing an electrical output modulated with an input signal and for producing light modulated with said input electrical signal, comprising the steps of:

providing a heterostructure bipolar transistor device that includes collector, base, and emitter regions of direct bandgap semiconductor materials, said base region being heavily doped;

applying electrical signals to said collector, base, and emitter regions to cause light emission by radiative recombination in the base region; and

controlling the base current of said transistor device with said input electrical signal to modulate an electric output signal of said device and to modulate the light emission from said transistor device.

35. The method as defined by claim 34, wherein said step of applying signals includes applying an emitter-to-base forward bias and base-to-collector reverse bias.

36. The method as defined by claim 34, wherein said step of applying electrical signals to cause light emission includes applying base current to produce light emission that is substantially proportional to the applied base current.

37. A display, comprising:

an array of heterojunction bipolar transistor devices that include collector, base, and emitter regions of direct bandgap semiconductor materials; and

means for applying electrical signals across terminals coupled with said collector, base, and emitter regions of said

devices to cause light emission by radiative recombination in the base regions of said devices.

38. The display as defined by claim 37, wherein said means for applying signals includes modulating the light output of individual devices of the array by applying signals that control the base currents of said devices.

39. An optoelectronic method, comprising the steps of:

providing a heterojunction bipolar transistor device that includes collector, base, and emitter regions;

applying electrical signals across terminals coupled with said collector, base, and emitter regions to cause light emission by radiative recombination in the base region; and

providing an optical coupling to the light emitted from said base region.

40. The method as defined by claim 39, wherein said step of applying electrical signals includes applying a collector-to-emitter voltage and modulating light output by applying a modulating base current.

41. The method as defined by claim 39, wherein said step of providing a heterojunction bipolar transistor device comprises providing a device formed of direct bandgap materials.

42. The method as defined by claim 39, wherein said step of providing a heterojunction bipolar transistor device comprises providing a device formed of indirect bandgap materials.

43. The method as defined by claim 39, wherein said step of applying electrical signals to cause light emission includes applying base current to produce light emission that is substantially proportional to the applied base current.

44. The method as defined by claim 41, wherein said step of providing a heterojunction bipolar transistor includes providing at least one quantum well layer in the base region of said heterojunction bipolar transistor.

45. The method as defined by claim 42, wherein said step of providing a heterojunction bipolar transistor includes providing at least one quantum well layer in the base region of said heterojunction bipolar transistor.

46. The method as defined by claim 41, wherein said step of providing a heterojunction bipolar transistor includes providing at least one quantum dot region in the base region of said heterojunction bipolar transistor.

47. The method as defined by claim 42, wherein said step of providing a heterojunction bipolar transistor includes providing at least one quantum dot region in the base region of said heterojunction bipolar transistor.